

# THE SALAMANDERS OF THE GENERA DESMOGNATHUS AND LEUROGNATHIUS.

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## INTRODUCTION.

Although one of the species of *Desmognathus* is the commonest of the eastern salamanders, it was not observed by scientists until 1818, when Green described *Salamandra fusca*. This name was preoccupied by a name of Laurenti's. In the same paper Green described *Salamandra nigra*, which name has been used for a species of *Desmognathus* that Green probably never saw. In 1820 Rafinesque described *Triturus fuscus*, which is the earliest tenable name for a species of *Desmognathus*. This name of Rafinesque's remained unnoticed until 1849, the names *picta* (Harlan 1825), *nigra* (Green 1818), and *intermixta* (Green 1825), all being applied to the species now known as *fusca*. In 1838 Holbrook described *auriculata*, and in 1840 *quadramaculata*. He was the first to apply Green's *nigra* to the large black adult of *quadramaculata*. In 1849 Baird described the genus *Desmognathus* recognizing three species: *D. fusca* (Rafinesque), *D. auriculata* (Holbrook), and *D. nigra* (Green).<sup>1</sup> He placed *quadramaculata* in the synonymy of *fusca* where it stayed until Stejneger resurrected it in 1903.

Cope described *ochrophaea* in 1859. In 1866 he created a family, Desmognathidae, with only one genus. In 1868 he made *auriculata* a subspecies of *fusca*. In 1882 Boulenger added the genus *Thorius* Cope to the Desmognathinae. In 1892 Stejneger described *Typhlotriton* placing it in this family. So also in 1893 Cope in describing *Haptoglossa* included it in the Desmognathidae. Stejneger described *D. brimleyorum* in 1895. In 1899 Moore described *Leurognathus* as of the family Desmognathidae. In 1900 Moore showed clearly that this family had no standing if based on the opisthocelous vertebrae.

In 1901 Allen claimed that *ochrophaea* should be a synonym of *fusca* and Fowler in 1906 supported his claim. In 1903 Stejneger

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<sup>1</sup> The "only" specimen of *nigra* seen by Baird was No. 14001 in the Academy of Natural Sciences of Philadelphia. It was presented by Holbrook and the locality is given as "Penn."

redescribed *quadramaculata* as distinct from the form long known as *D. nigra* (Green). In 1908 Brown designated *D. fusca* (Rafinesque) as the type of *Desmognathus*. In preparing this revision I described *monticola* and *carolinensis*.

Passing from the systematic history of the group, one is struck by the number of papers on the anatomy and physiology of one form: *fusca*. This species, so easily obtainable throughout the East, has served as the basis for the researches of the Wilder's on the peculiarities of lungless salamanders. Mrs. Wilder has carefully worked out its life-history. Others have studied various phases of its morphology and embryology, so that this animal is by far the best known of the Plethodontidae.

#### MATERIAL.

Of *Leurognathus marmorata* I have seen six specimens. The type and one collected by S. N. Rhoads, in the Academy of Natural Sciences of Philadelphia; and two cotypes, an alcoholic and a skeleton, and an additional specimen in the University of Pennsylvania; and a larva in the American Museum of Natural History.

Of *Desmognathus* I have examined the following specimens: 1,093 in the United States National Museum; 1,105 in the Academy of Natural Sciences; 526 in the American Museum of Natural History; 56 in the Museum of Comparative Zoölogy; 52 in the Museum of the University of Pennsylvania; 144 in the Museum of Cornell University; and 194 in my private collection, making a total of 3,170.

The United States National Museum contains all the existing types of species of *Desmognathus*, i. e., of *D. brimleyorum* Stejneger, *D. monticola* Dunn and *D. ochrophaea carolinensis* Dunn.

#### ACKNOWLEDGMENTS.

I desire to express my gratitude to Mr. Leonhard Stejneger, who suggested this research to me, for his kind advice and assistance, and for permission to study the collection of the United States National Museum; to Mr. R. G. Paine and Mr. H. A. O'Dwyer, of the Division of Reptiles, for help in studying the collection; to Dr. H. W. Fowler, who allowed me to study the collection of the Academy of Natural Sciences in Philadelphia, for his interest and suggestions; to Miss Mary C. Dickerson, who gave me the opportunity to study the North Carolina fauna in life, and who lent me the collection of the American Museum of Natural History, in New York City; to Dr. Thomas Barbour, who lent me specimens from the Museum of Comparative Zoölogy, in Cambridge, Massachusetts; to Dr. Percy Moore, who gave me the opportunity to study his specimens of *Leurognathus* and *Desmognathus* in the University of Pennsylvania Museum, and who permitted me to use his drawings of *Leurognathus*; to Dr. A. H. Wright, of Cornell University, for the loan of specimens; to Dr. and

Mrs. Wilder, of Smith College, Northampton, Massachusetts, for advice and specimens; and finally to Dr. H. S. Pratt, of Haverford College, under whom I studied, who has shown great interest in this work, and allowed me to use the resources of the college laboratory with the greatest freedom, especially in the matter of procuring specimens

#### RELATIONSHIPS OF THE GENERA.

Cope established a family Desmognathidae on the strength of the opisthocelous vertebrae of *Desmognathus*. *Thorius*, *Haptoglossa*, *Typhlotriton*, and *Leurognathus*, were added at various times to the family chiefly on this character. Moore (1900) showed that opisthocelous vertebrae are in many salamanders concomitant with age, and that old specimens of various species of *Spelerpes*, *Gyrinophilus*, and *Autodax* have vertebrae quite as opisthocelous as has *Desmognathus*. Consequently the family can not stand.

*Thorius* Cope, with a boletoid tongue and prefrontal bones, tends to *Spelerpes*.

*Typhlotriton* according to Cope (1893a) has the same peculiar structure of the atlas found in *Desmognathus* and *Leurognathus*. However, it has prefrontal bones and a premaxillary fontanelle. The tongue is attached in front, although according to Hilton (1909b), it is in the larval state more like the tongue of *Spelerpes* than that of *Desmognathus*.

Its position, then, would be between these two genera.

*Leurognathus* Moore seems closely related to *Desmognathus* in structure of tongue and skull. The prefrontal bones are lacking in both. The peculiar structure of the atlas is alike in both. *Leurognathus* so far as known never has vomerine teeth. In this it is unique save that the males of some species of *Desmognathus* lose the vomerine teeth on arriving at sexual maturity.

The cranial structure of *Haptoglossa* Cope is unknown.

*Batrachoseps* Bonaparte has no prefrontal bones, but this has been shown by Cope to be an independent loss and the genus tends to *Plethodon*. *Stereochilus* Cope is not well known. Cope says that in the only skull he examined the prefrontal bone was present on one side and absent on the other. Besides *Leurognathus*, *Stereochilus* is, according to Cope, the only other genus of Plethodontidae without premaxillary fontanelle. This may or may not indicate relationship.

Therefore *Desmognathus* and *Leurognathus* form a closely related group, which is apparently isolated from other genera of Plethodontidae.

However, the cranial structure of *Haptoglossa* and *Stereochilus* should be examined for possible relationships.

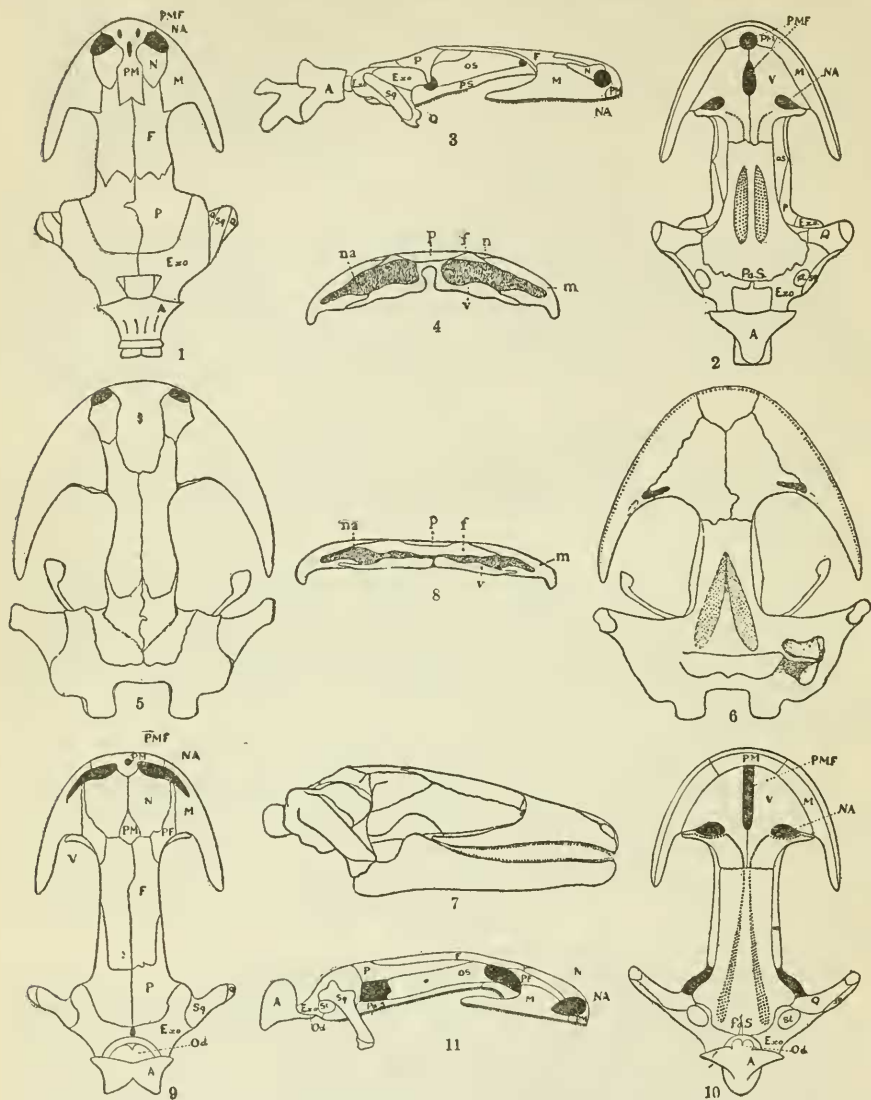


FIG. 1.—DORSAL VIEW OF SKULL OF *DESMOGNATHUS FUSCA*,  $3 \times$  NAT. SIZE. A, ATLAS; ExO, EXOCIPITAL BONE (THE OCCIPITO-PETROSAL OF WIEDERSHEIM); F, FRONTAL BONE; M, MAXILLARY BONE; NA, NARES; N, NASAL BONE; P, PARIETAL BONE; PM, PREMAXILLARY BONE; PMF, PREMAXILLARY FONTANELLE; Q, QUADRATE BONE; Sg, SQUAMOSAL BONE.

FIG. 2.—VENTRAL VIEW OF SAME,  $3 \times$  NAT. SIZE (TEETH SOMEWHAT DIAGRAMMATIC); Os, ORBITO-SPHENOID BONE; PaS, PARASPHENOID BONE; St, STAPES; V, VOMER; OTHER LETTERS AS BEFORE.

FIG. 3.—LATERAL VIEW OF SAME,  $3 \times$  NAT. SIZE. LETTERS AS BEFORE.

FIG. 4.—A SECTION OF THE SKULL OF *DESMOGNATHUS QUADRAMACULATA* TAKEN JUST ANTERIOR TO THE INTERNAL NARES,  $3.5 \times$  NAT. SIZE. f, FRONTAL; m, MAXILLARY; n, NASAL; na, NASALPASSAGE, WHICH IS INDICATED BY SHADING; p, PREMAXILLARY; v, VOMERO-PALATINE.

FIG. 5.—DORSAL VIEW OF A FEMALE *LEUROGNATHUS MARMORATA*,  $3.2 \times$  NAT. SIZE.

FIG. 6.—VENTRAL VIEW OF SAME,  $3.2 \times$  NAT. SIZE. THE INTERNAL NARES ARE BLACKENED, AND THE POSITION OF THE ACTUAL CHOAENAE IN THE ENTIRE HEAD IS INDICATED BY A RING OF DOTS.

FIG. 7.—LATERAL VIEW OF SAME,  $3.2 \times$  NAT. SIZE.

FIG. 8.—A SECTION OF THE SKULL OF THE SAME TAKEN JUST ANTERIOR TO THE INTERNAL NARES,  $3.5 \times$  NAT. SIZE. LETTERS AS IN FIG. 4.

FIG. 9.—DORSAL VIEW OF SKULL OF *SPELERPES RUBER*,  $3 \times$  NAT. SIZE. Od, ODONTOID PROCESS OF ATLAS; PF, PREFRONTAL BONE; OTHER LETTERS AS BEFORE.

FIG. 10.—VENTRAL VIEW OF SAME,  $3 \times$  NAT. SIZE. LETTERS AS BEFORE. (TEETH SOMEWHAT DIAGRAMMATIC.)

FIG. 11.—LATERAL VIEW OF SAME,  $3 \times$  NAT. SIZE. LETTERS AS BEFORE.

[Figs. 1-3 and 9-11 by the author; figs. 4-8 are here reproduced by the kind permission of Dr. Moore.]



## VARIATION OF THE CHARACTERS.

*Dentition.*—This has been studied chiefly by taking impressions of teeth on thin shavings of a preparation of beeswax and lampblack.

The shape and presence of the vomerine teeth are quite constant in the various forms. The females always have them, but the males of all species save *quadramaculata* and *monticola* lose them at sexual maturity. Some, but not all, old male *monticola* lack the vomerines.

In some specimens of *fusca* and in most of *ochrophaea* and *carolinensis* the vomerine teeth are on a bony ridge which often persists after the teeth themselves are lost.

The parasphenoid patches change somewhat in shape with age and are slightly different in male and female. Aside from this they are variable and must be used only in connection with other characters.

The mandibular dentition of male *ochrophaea* is merely an exaggeration of that seen in male *fusca*, but it is marked and constant. The shape of the tongue is subject to so much variation, which is probably due to differences of preparation, that I have been unable to use it as a diagnostic character.

*Tail and limbs.*—The shape of the tail is constant and not subject to sexual or seasonal changes. I have found no seasonal changes in these salamanders, save that "in the breeding season the lips of the cloaca are somewhat everted" (Mrs. Wilder). The absence of the dorsal fold is characteristic of the *ochrophaea* group.

The relative length of the tail is also fairly constant. The tails are frequently broken and regenerated, so that it is impossible to tell the normal. Results of maximum tail-lengths range the species in the same order as average tail-lengths so that any error resulting from mutilation is of no consequence.

The size of the legs is quite constant in specimens of the same age. The distance between the appressed toes is less in youth than in age. But the change is not the same for all forms. Thus young *monticola* have two intercostal spaces between the appressed limbs and old *monticola* three; while young *fusca* have three and a half and old ones four. The larvae, young, and adult of *quadramaculata* have two and a half to three quite constantly.

*Head.*—The skin of the head is sometimes very rugose. This is very noticeable in specimens of *quadramaculata* and *monticola*. While the majority of specimens possess it, I have been able to find no other character accompanying it and am inclined to set its absence down to an artifact of preservation or an individual or local variation. It is not usually found, however, in old and black specimens of *quadramaculata*.

The size of the head is a constant but hard to use, as it has to be relative and the limits of variation are small.

*Size*.—Adult size is subject to some local variation, but is otherwise constant. In the *fusca* and *ochrophaea* groups males are larger than females.

The disparity in size is greater than the total length measurement would show, as the tails of females are larger than the tails of males. Similarly the much greater size of *quadramaculata* is better shown when measurements of head and body are compared as the shortness of the tail in this form obscures the difference when total lengths are compared.

*Costal grooves*.—The costal grooves are not of much use in separating forms of this genus. They vary from a minimum of 12 in *quadramaculata* to a maximum of a possible 15 in *brimleyorum*. Fourteen is normal, counting the axillary and inguinal. The inguinal in specimens with 14 may be either a distinct groove or a fork of the thirteenth. Where there are only 12 this fork is lacking and No. 1 does not quite reach into the axilla. To quote from Cope (1889) speaking of *ochrophaea*: "The costal folds are 13, but 14 if that which is immediately above the groin be counted. The first falls immediately into the axilla. This is the characteristic arrangement in *D. fusca* also, while in *D. nigra* the fold above the groin usually extends to it and is the twelfth, while that which corresponds to the first of the species last named falls just in advance of the axilla. Though this is typical of *D. nigra*, occasionally another plica appears above the groin and the twelfth is slightly in front of it."

It will be seen from this that the number of costal grooves in this genus can not be used as a character of any great value.

The tubercle canthus oculi is present in all forms save typical *ochrophaea*. I have been unable to use the lateral pores as diagnostic characters. This is largely because the distinctness of these pores is so dependent on the preservation. In some specimens they are quite evident. In others of the same species they are scarcely to be observed at all.

*Color*.—The shades are extremely variable, but I have found the general markings to be quite constant. In all of the forms there is a marked tendency for the dorsal surface to become black with age.

In *quadramaculata* the ventral surface also becomes dark with age, and *carolinensis* and *monticola* show a tendency in this direction. In the other species the belly assumes its permanent coloration shortly after transformation.

*Measurements*.—In measurements the head length is taken from the tip of the snout to the middle of the gular fold. The head width is taken at the angle of the jaws. The tail is taken as beginning at the posterior angle of the vent.

# Subfamily DISMOGNATHINAE.

## Key to the genera.

a<sup>1</sup> Internal nares conspicuous, about as far apart as nostrils. . . . . *Desmognathus*.

a<sup>2</sup> Internal nares very inconspicuous, twice as far apart as nostrils. *Leurognathus*.

## Genus DESMOGNATHUS Baird.

1849. *Desmognathus* BAIRD, Journ. Acad. Nat. Sci. Philadelphia (n. s.), vol. 1, p. 82.

1851. *Cylindrosoma* (part) DUMÉRIL and BIBRON, *Erpétologie Générale*, vol. 9, p. 81.

1854. *Plethodon* (part) DUMÉRIL and BIBRON, *Erpétologie Générale*, vol. 9, p. 85.

1854. *Ambystoma* (part) DUMÉRIL and BIBRON, *Erpétologie Générale*, vol. 9, p. 105.

1856. *Plethodon* (part) HALLOWELL, Proc. Acad. Nat. Sci. Philadelphia, pp. 6-11.

*Type-species*.—*Triturus fuscus* Rafinesque.

*Diagnosis*.—General characters of the Plethodontidae. Tongue attached, except by its lateral margins. Prefrontal bone wanting. Premaxillaries united, embracing a fontanelle. Structure of internal nares as in *Spelerpes*; that is, a notch in the vomer.

Vertebrae opisthocoelous in the adult. Atlas without odontoid process and with a transverse dorsal ridge on which the temporal muscles originate.

Occipital condyles on cylindric pedestals. Vomerine teeth usually present, but wanting in adult males of some species. A light line from the eye to the angle of the jaw.

There seems to be three groups of nearly equal value. These are:

1. *quadramaculata*; 2. *monticola*, *fusca*, *auriculata*, and *brimleyorum*;
3. *carolinensis* and *ochrophaea*.

*Distribution*.—The forms of *Desmognathus* occur all over the eastern United States. Two specimens show that the genus is represented in New Brunswick. There is also a record for the Gaspe peninsula, but as this refers to larvae it is extremely doubtful. Nash's records for *D. fusca* and *D. nigra* in southwest Ontario are also doubtful. It can be affirmed with considerable positiveness that *quadramaculata* does not occur in Canada, and from the known distribution of *fusca* it seems scarcely probable that it either is found in Ontario.

Specimens and records are lacking from northwestern Ohio, northern Indiana, northern Illinois, western Kentucky, western Tennessee, and northern Mississippi. In Arkansas, *brimleyorum* from two neighboring localities is the only representative. Beyer (1900) records *fusca* as common all over Louisiana. I have seen specimens from only the southeastern corner and these were *auriculata*. It is very doubtful whether typical *fusca* occurs in Louisiana.

In mapping the ranges of the various forms one is struck by the agreements with the maps in Transeau's paper on the Forest Centers

of Eastern North America. Thus the distribution of *fusca* is roughly the eastern deciduous forest; *ochrophaea* the northern coniferous forest; *carolinensis* the southern extension of the same; and *auriculata* the southern coniferous forest.

LIST OF SPECIES AND SUBSPECIES WITH TYPE-LOCALITIES.

*Desmognathus quadramaculata* (Holbrook), Carolina.

*Desmognathus monticola* Dunn, Brevard, North Carolina.

*Desmognathus fusca fusca* (Rafinesque), northern New York.

*Desmognathus fusca auriculata* (Holbrook), Riceboro, Georgia.

*Desmognathus brimleyorum* Stejneger, Hot Springs, Arkansas.

*Desmognathus ochrophaea ochrophaea* Cope, Susquehanna County, Pennsylvania.

*Desmognathus ochrophaea carolinensis* Dunn, Mount Mitchell North Carolina.

Key to adults of *Desmognathus*.

- a<sup>1</sup>. Tail not keeled, cylindrical. Small species.
  - b<sup>1</sup>. No tubercle in the anterior angle of the eye; belly light.....  
*D. ochrophaea ochrophaea*.
  - b<sup>2</sup>. A tubercle in the anterior angle of the eye; belly dark.....  
*D. ochrophaea carolinensis*.
- a<sup>2</sup>. Tail keeled above. Large and medium species.
  - b<sup>1</sup>. Belly uniformly colored.
    - c<sup>1</sup>. Belly black; large and stout; tail short.....*D. quadramaculata*.
    - c<sup>2</sup>. Belly light; tail long; no light spots on sides.....*D. monticola*.
  - b<sup>2</sup>. Belly mottled.
    - c<sup>1</sup>. No light spots on sides .....*D. fusca fusca*.
    - c<sup>2</sup>. A row of light spots on sides.
      - d<sup>1</sup>. Belly dark.....*D. fusca auriculata*.
      - d<sup>2</sup>. Arkansas. Belly light .....*D. brimleyorum*.

IDENTIFICATION OF LARVAE.

From the larvae of other genera of Plethodontidae (except only *Leurognathus marmorata*, q. v.) larvae of *Desmognathus* may be told by their glistening white gills, which are never so long or so large as the gills of *Spelerpes*, etc., larvae. The legs are stout, especially the hind pair. The whole outline of the body and the markings are very like those of the adult. I have seen larva of *quadramaculata* and *fusca*. These may be distinguished by the larger size and uniform pigmentation of *quadramaculata*. Larvae of *fusca*, *monticola*, or *carolinensis* are not found during July and August, but larvae of *quadramaculata* are found throughout the summer.

Larvae of *fusca* are found among leaves and débris in very shallow water near the surface. Larvae of *quadramaculata* are found under rocks in the mountain brooks where the adult is also found.

*Spelerpes* larvae, on the other hand, are usually found on the bottom of springs and small streams.



## DESMOGNATHUS QUADRAMACULATA Holbrook.

1840. *Salamandra quadramaculata* HOLBROOK, N. Amer. Herpetology, ed. 1, vol. 4, pl. 27.  
 1840. *Salamandra maculo-quadrata* HOLBROOK, N. Amer. Herpetology, vol. 4, p. 121.  
 1842. *Salamandra quadrimaculata* HOLBROOK, N. Amer. Herpetology, ed. 2, vol. 5, p. 49, pl. 13.  
 1842. *Triton niger* (part) HOLBROOK, N. Amer. Herpetology, ed. 2, vol. 5, p. 81 (not of Green).  
 1849. *Desmognathus niger* BAIRD, Journ. Acad. Nat. Sci. Philadelphia, (n. s.) vol. 1, p. 285.  
 1854. *Ambystoma nigrum* DUMÉRIL and BIBRON, Erpétologie Générale, vol. 9, p. 125.  
 1903. *Desmognathus quadrimaculata* STEJNEGER, Proc. U. S. Nat. Mus., vol. 26, p. 557.

*Type*.—So far as known there is none.

*Type-locality*.—Holbrook (1840) says "I first found it in the Carolinas."

*Distribution*.—From Wytheville and Giles County, Virginia, southward in the Alleghenies into Georgia and South Carolina. Zonal range Transition and Canadian. Vertical range, 2,000–6,000 (Roan Mountain).

*Diagnosis*.—Vomerine teeth always present. Parasphenoid series confluent anteriorly. Legs stout. Two and a half to three costal interspaces between appressed toes. Tail flattened, keeled, and finned above. Head very large. Size large. No distinct color pattern. Belly black. Larvae: Total length to 79 mm. Transformed specimens: Total length 49–164 mm. Head and body 27–100 mm.

*Description*.—The vomerine teeth are always present and form two arched series which extend nearly to the nares and approach each other posteriorly within one-fourth of their own length. When complete there are 8–9 teeth in each series. The parasphenoid series are very long narrow patches, confluent anteriorly, which approach the vomeries from one-third to two-thirds the length of the vomerine series.

The tongue seems usually small and round, but it is variable.

The tail is always shorter than the head and body, and is usually flattened and finned.

The legs are very large and stout. The number of costal spaces between the appressed toes is two and a half to three.

The head length is from three and two-thirds to four and a half in the length of head and body. The head width is about five in the length of head and body.

This is the largest species in the genus, with a long head, long body, short tail, and long legs.

The skin of the head is often rugose, resembling, as Stejneger says, "grain leather." This character is present in *monticola* and to some degree in *carolinensis*. Old and black specimens of *quadramaculata* do not, as a rule, have it. In nine specimens from Giles County, Virginia, five had the head perfectly smooth, in two it was very rough, and two were intermediate. The tubercle canthus oculi is always present.

The X-shaped groove on top of the head, between and in front of the eyes, is lacking in this species. It is present in all the other

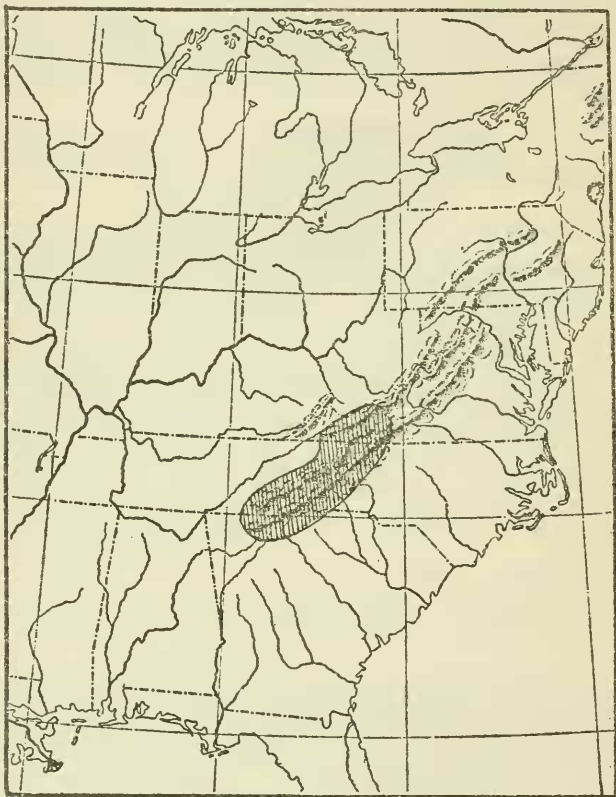


FIG. 12.—RANGE OF DESMOGNATHUS QUADRAMACULATA.

forms of the genus. This is useful in separating this form from dark *monticola*.

In this form the costal grooves are at a minimum. Some specimens have only 12; others have 13 and 14.

The color of this form is very characteristic. The dorsal surface shows a lack of pattern not found in any other species. The larva is almost uniform brownish above and uncolored below. The young are at first like the larvae, but the dorsal color becomes gradually darker until it is black in old specimens. The color of the head is, in most specimens, much lighter than that of the body. The belly,

white in the young, soon begins to blacken in an area laterally very definitely defined by a line between the ventral insertion of the legs. Medium-sized specimens have the back dark, the sides light, and the belly dark. The dorsal surface is never lighter than the sides as it is in all the other forms of the genus. Old specimens become uniformly black save for the head and feet which remain brownish and whitish.

In view of the lack of definite color pattern, question may arise as to the applicability of Holbrook's name to this species. The proportions and ventral coloration of Holbrook's plate are those of this form. The dorsal spots are more distinct in Holbrook's figure than in any specimen I have seen. But, as Stejneger says, some specimens approach it and the other characters agree exactly with this form and with no other.

I can find no sexual differences in this form. The testes are not pigmented, as are those of *fusca* and *ochrophaea*.

*Habits*.—According to my own experience, this is by far the most aquatic species of the genus. I have found them swimming about in streams as large as the Linville River. They are extremely active and hard to catch or hold. It is a surprising sight to see one of these big black salamanders run down a sloping bank into the water for all the world like a water snake.

On several occasions captured specimens attempted biting.

Around Brevard, North Carolina, they came down to 2,100 feet in large streams, to which they seemed practically confined. At Linville, North Carolina, where the valley was 3,800 feet, they inhabited large and small streams, irrespectively.

The explanation seems to be that *D. monticola* inhabits small streams which rise at or below 4,000 feet, while *D. quadramaculata* follows down streams which rise above that line. This is not an absolute rule, but it holds in most cases, and a stream in which *quadramaculata* is common usually contains few *monticola*, and the opposite.

The food seems not definitely known.

Nothing has been published on the breeding habits. The condition of the ovaries in females would indicate September as the beginning of the egg-laying period. Specimens have been seen which were taken in May, July, and September. In May the eggs were not developed. In July the eggs were in all cases well developed. In September the eggs were developed in some cases and not in others. This would show that some of the September females had spawned and others had not.

The larvae reach a much larger size than in any of the other species. The smallest transformed example seen was 52 mm. long, and the largest larva was 79 mm. long. Females appear to be

sexually mature at a total length of 107 mm. with head and body 57 mm.

*Remarks.*—This seems the most primitive form in the genus. Its larvae are the largest. The male never loses its vomerine teeth. There is no difference between male and female in size or hooking of the jaws.

In these characters it leans away from the other species of *Desmognathus* and toward the majority of salamanders. Two other points of interest are that its size is the largest of the genus and that it is strikingly similar externally to *Leurognathus marmorata*, the only species of the only closely allied genus.

There are several specimens of this form with doubtful locality records. These are: No. 183 Mus. Comp. Zool., presented by Doctor Holbrook, locality Charleston, South Carolina; No. 14001 Acad. Nat. Sci., presented by Doctor Holbrook, locality Pennsylvania; No. 3883 U.S.N.M. Meadville, Pennsylvania; No. 3823 U.S.N.M. Cook County, Illinois; No. 8802 U.S.N.M. Augusta, Georgia. Aside from these the specimens are all within the distribution given. No modern specimens of this unmistakable form are known from outside this range.

Green's *Salamandra nigra* (1818) is not this form. Holbrook's two specimens are the oldest ones known and hence it is doubtful if Green ever saw a specimen of what has been called *Desmognathus nigra* (Green).

Specimens examined: 213, from the following localities:

*Illinois.*—Cook County (?) 1.

*Pennsylvania.*—1 (?); Meadville (?), 1.

*Virginia.*—Wytheville, 1; Giles County, 9.

*North Carolina.*—Cherokee, 1; Bald and Sampson Mountains, 1; Haywood County, 3; Pink Beds, 3; Brevard, 61; Blantyre, 5; Mount Mitchell, 3; Spruce Pine-Micaville, 1; Henderson County, 3; Pineola-Mortimer, 7; Linville, 43; Blowing Rock, 49; Grandfather Mountain, 3; Roan Mountain, 4.

*Tennessee.*—1; Roan Mountain, 1.

*South Carolina.*—Abbeville, 2; Charleston (?), 1.

*Georgia.*—1; Augusta (?), 1.

*No locality.*—Three.

#### DESMOGNATHUS MONTICOLA Dunn.

1916. *Desmognathus monticola* DUNN, Proc. Biol. Soc. Washington, vol. 29, p. 73.

*Type.*—No. 38313 U.S.N.M., adult male.

*Type-locality.*—Elk Lodge Lake, near Brevard, North Carolina; altitude about 2,500 feet. Type collected by Ronald and Emeline Tipping, July 13, 1908.

*Distribution.*—From Clarke County, Virginia, and Greenbrier County, West Virginia, south in the mountains to Toccoa, Georgia.



Zonal range transition. Vertical range: 500 feet (Clarke County, Virginia), 4,500 feet (Tatula Mountain, North Carolina).

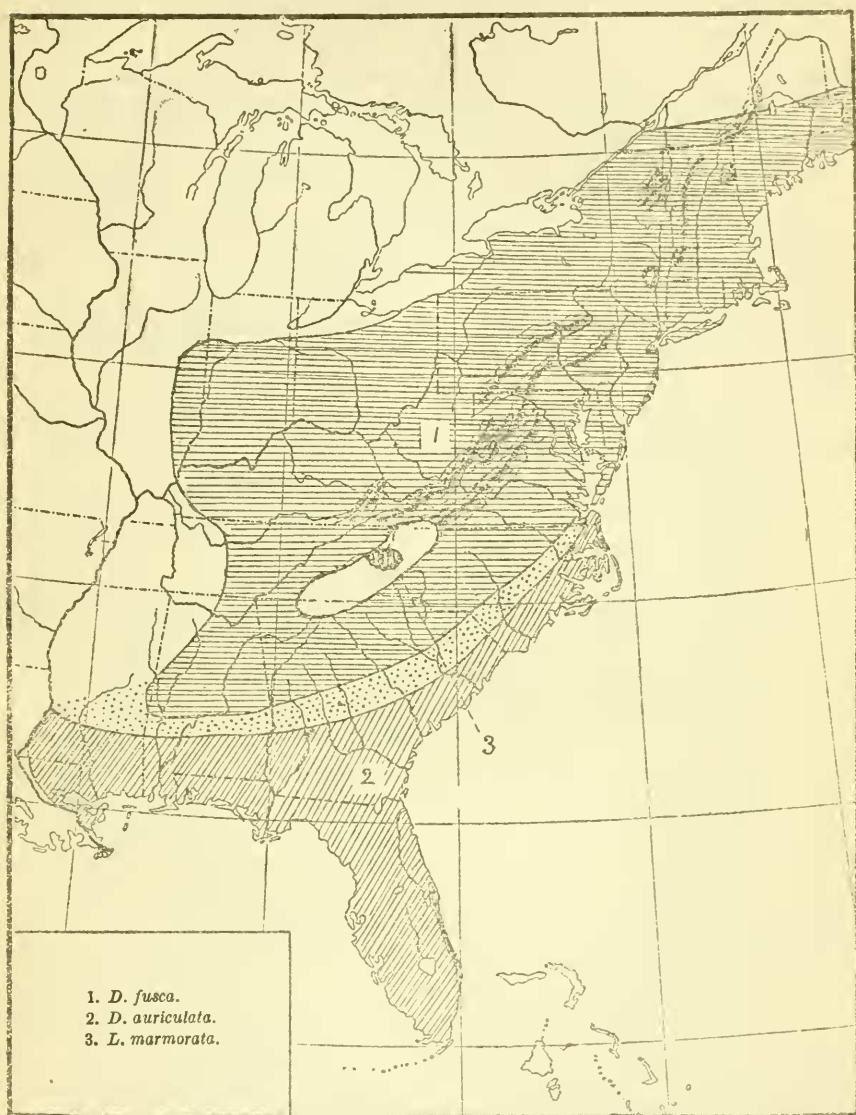


FIG. 13.—RANGES OF 1, DESMOGNATHUS FUSCA FUSCA; 2, *D. FUSCA AURICULATA*; 3, LEUROGNATHUS MARMORATA. (DOTTED AREA SHOWS INTERGRADATION.)

*Diagnosis*.—Vomerine teeth not lost by males on reaching sexual maturity. (The largest and probably the oldest males lack these teeth. Others, however, many as large as the largest *fusca* and undoubtedly sexually mature, have these teeth. When lost it is a senile change.) Parasphenoids confluent anteriorly. Legs stout.

Three costal interspaces between appressed toes of adult. Tail keeled above. A distinct color pattern. Belly uniform, pale. Transformed specimens: Total length 30–135 mm.; head and body 17–64 mm.

*Description.*—The vomerines form two short slightly arched series which approximate each other in the median line. The parasphenoids are usually confluent anteriorly. They are long narrow series and are well separated from each other save in front. Their distance from the vomerines is about equal to the length of one of the vomerine series. The shape of the tail is about as in *fusca*. The relative length is greater. It is not as flattened as in *quadramaculata*.

The legs are stout. In young specimens the appressed toes are separated by two costal interspaces, in adults by three.

The length of the head is from four to four and a half in the length of head and body. The head is from five to six in the length of head and body.

This is the second largest form in the genus with medium head and body, long tail, and medium legs.

The skin of the head is often rugose as in *quadramaculata*. The costal grooves are 13 or 14 in number. There is always a tubercle in the anterior angle of the eye.

The color of this form is much like that of *fusca*, but shows certain differences. The light dorsal spots are smaller and more heavily outlined with dark. They do not break up until the animal is practically mature; whereas in *fusca* it is seldom, even in the smallest transformed specimens, that they have not coalesced into a light dorsal band. When these spots do coalesce in *monticola* portions of the dark outline are left as conspicuous dark spots on the generally pale dorsal band. The ventral coloration is practically uniform and lacks all trace of the mottling so conspicuous in *fusca*. The sides are not mottled as in *fusca*, but the dark lateral band merges gradually into pale ventral surface. In the young the belly is white. A uniform pigmentation gradually encroaches on the belly from the sides inward and from behind forward, so that the last unpigmented part of the ventral surface is between the fore legs. Eventually the whole belly is uniformly and lightly pigmented. In a few specimens this pigmentation is fairly dark, never, however, becoming as dark as in *quadramaculata*. In comparing *monticola* with the latter, it should be remarked that *monticola* usually retains traces of the dorsal pattern and never has the light lateral band so characteristic of young and medium *quadramaculata*.

The only sexual difference discernible is the very slightly more flexuous outline of the male jaw. The testes are unpigmented as in *quadramaculata*.

*Habits.*—This species resembles *fusca* very closely in its habitat relations. It is not nearly so aquatic as *quadramaculata*, and is found only in small streams. The rocky edges of the mountain

brooks and the springs along the sides of the roads simply teem with this species. It wanders more openly than do the other species of the genus. I once sat on the side of a road under a tree during a rain and four or five large examples crossed the road in half an hour. While we were climbing Grandmother Mountain early one morning, one ran across our path with a partially swallowed earthworm in its mouth. In this roaming tendency it resembles *quadramaculata*, which is also frequently seen in action, but which is confined to streams.

The vertical range of those observed by me was from 2,200 to 4,000 feet. This applies only to the North Carolina mountains. In Virginia it comes down to 500 feet.

No larvae have been seen. The breeding habits are not known, but they are probably similar to those of *fusca*. Transformed specimens have been seen as small as 30 mm. Females seem to be sexually mature at a total length of 105 mm.; head and body, 51 mm.

*Remarks.*—This animal is intermediate between *fusca* and *quadramaculata*, with which two species it was confused. It is the only species of the genus besides *quadramaculata* in which the male retains the vomerine teeth past sexual maturity.

It is apparently distinct from both of the others, as no specimens of an intermediate nature have been seen, and as it occurs with *quadramaculata* in North Carolina, and with *fusca* in Virginia.

Specimens examined, 173, from localities as follows:

*Virginia.*—Delaplane, 2; Clarke County, 1; Berry's Ferry, Clarke County, 1; Hanging Rock, Clarke County, 8; Stony Man, 1; Augusta County, 2.

*West Virginia.*—Greenbrier County, 2; Baileysville, 2; Star Creek, 2; Horsepen Creek, 1; Big Stony Creek, near Barger's Spring, 1.

*North Carolina.*—Brevard (type-locality), 90; Pink Beds, 9; Blantyre, 4; Sunburst, 3; Joanna Bald, near Andrews, 1; Burnsville, 1; Cane River, 3; Spruce Pine-Micaville, 1; Linville, 18; Blowing Rock, 2; Pineola-Mortimer, 1; Tatula Mountain, near Highlands, 1.

*Georgia.*—Clayton, 1; Tallulah Falls, 4; Toccoa, 1.

#### DESMOGNATHUS FUSCA FUSCA (Rafinesque).

1818. *Salamandra fusca* GREEN, Journ. Acad. Philadelphia, vol. 1, pp. 348-359 (not of Laurenti, 1768).

1820. *Triturus fuscus* RAFINESQUE, Annals of Nature, vol. 1, p. 4.

1825. *Salamandra intermixta* GREEN, Hall's Portfolio, vol. 20, p. 159.

1842. *Triton niger* (part) HOLBROOK, N. Amer. Herp., ed. 2, vol. 5.

1849. *Desmognathus fuscus* BAIRD, Journ. Acad. Philadelphia (n. s.), vol. 1, p. 285.

1854. *Plethodon fuscum* DUMÉRIL and BIBRON, Erpétologie Générale, vol. 9, p. 85.

1856. *Plethodon niger* HALLOWELL, Proc. Acad. Nat. Sci. Philadelphia, pp. 6-11.

*Type.*—Not known to exist.

*Type-locality.*—Northern New York.

*Distribution.*—From St. John's River, New Brunswick, and Rangeley, Maine, to Raleigh, North Carolina; Dayton, Alabama; David-

son County, Tennessee; Edmondson County, Kentucky; and Normal, Illinois.

It occurs as far up the French Broad River as Asheville, but is not otherwise known from the mountains of North Carolina.

*Diagnosis.*—Vomerine teeth lost in male on attainment of sexual maturity. Parasphenoids never confluent. Appressed toes separated by four intercostal spaces. Tail keeled above. A distinct color pattern. Belly mottled, light. No row of light spots on sides. Larvae: total length to 44 mm. Transformed specimens: Total length 29–100 mm., females, 128 mm., males; head and body 20–67 mm., males, 52 mm., females.<sup>1</sup>

*Description.*—Vomerine teeth always present in females; lost in males at sexual maturity. They form two arched series, which, when complete, are composed of five to six teeth. The series is separated by one and a half its length from the parasphenoids. They do not extend beyond the nares, but approach each other within one-fourth their own length.

The parasphenoid teeth form two rather short, thick, completely separated series.

The tail in the adult is trigonal in cross-section near the base, the distal half has a dorsal keel which is a simple fold of skin. This sometimes extends to the anus but usually only in young specimens.

The tail is larger in females than in males. In a series of 23 females from Haverford, Pennsylvania, 5 had the tail longer than the head and body, 2 had the tail equal to the head and body, and in 16 it was shorter. In 39 males from the same locality 1 had a tail larger, 1 had a tail of the same length as, and 37 had a tail shorter than the head and body.

The legs are not especially stout. There are four intercostal spaces between the appressed toes.

The length of the head is four and a half to five and a half in the length of head and body. The head width is five to six in the length of head and body.

I have seen no specimens of this form with the skin of the head rugose. The fact that I have seen no specimens from the North Carolina mountains may have some bearing on this point.

The tubercle canthus oculi is uniformly present. The male mandible is evenly and fully provided with teeth, but the outline of the jaw is strongly flexuous and serves as a very certain and easy means of distinguishing the sexes when adult.

The costal grooves are usually 14 in number.

The color of this species had best be described from the standpoint of development. The larval coloration is the key to that of the

<sup>1</sup> These measurements apply to specimens from southeastern Pennsylvania, from which region over 250 specimens have been available. The species averages smaller in the north and largest in North Carolina.



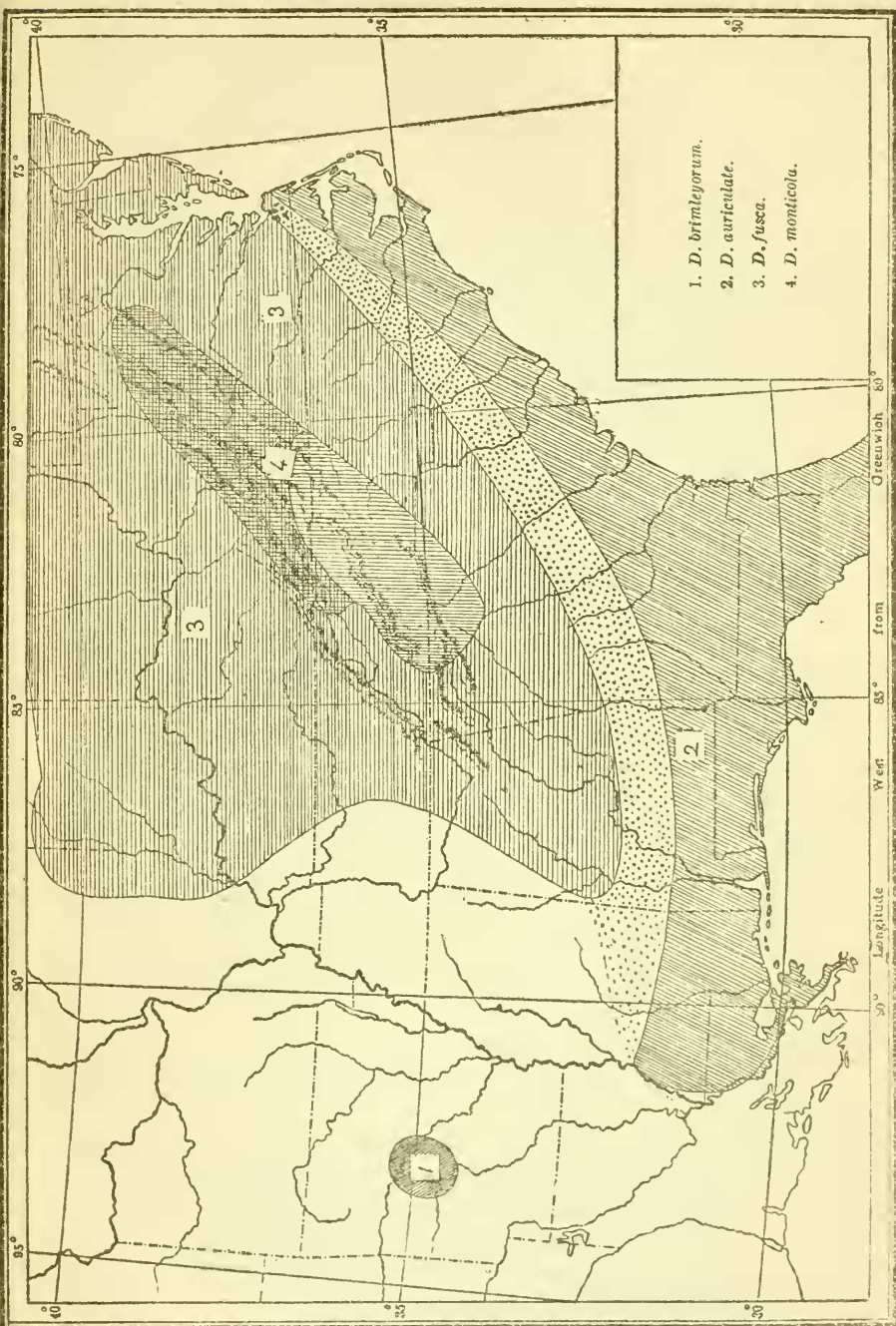


FIG. 14.—RANGES OF 1, DESMOGNATHUS BRIMLEYORUM; 2, *D. FUSCA AURICULATA*; 3, *D. FUSCA FUSCA*; 4, *D. MONTICOLA*.

[Note that in Virginia the ranges of *fusca* and *monticola* overlap, while *fusca* is absent from a large area in the North Carolina mountains. Dotted shows area of intergradation.]

adult. The ventral surface of the larva is unpigmented. The dorsal pigmentation is uniform save for a row of uncolored areas on each side of the middorsal line. These are the larval areas of Banta and McAtee (1906) and are quite as significant in the development of the color pattern of *Desmognathus fusca* as they are in that of *Spelerpes maculicardus*.

These pigmentless areas are in pairs on the body. They are confluent on the tail. At about the time of transformation the areas on the body become confluent and the result is a light dorsal band with crenulate edges. The sides below the crenulates are mottled and the mottling, shortly after metamorphosis extends over the ventral surface. The ground color which is not present in the larvae appears at metamorphosis.. It is extremely variable, becomes darker with age and appears to be chiefly responsible for the blackness of the whole upper surface in the old specimens. In young examples it may be yellow or red. The sides of the tail are mottled much as are the sides of the body.

The sexual differences in dentition, proportions of tail, and outlines of jaw have already been treated. Aside from this the male is larger than the female. The disparity in size is great. The largest male seen, from Raleigh, North Carolina, was 134 mm. total length. Head and body, 68 mm. The largest female seen, from Nelson County, Virginia, was 107 mm. total length. Head and body, 52 mm.

*Habits.*—The habits of *fusca* have received much attention and are quite well known. They seem to rarely enter the water, although they live in its immediate proximity. They take advantage of holes and burrows of other animals, but are able to make their own. They lie in these burrows with the head toward the entrance.

Mrs. Wilder (1913) says, "The ideal environmental conditions for *Desmognathus fusca*, as deduced from a study of those localities in which they occur in the greatest abundance, are those afforded by the banks of well shaded streams of shallow, perennially running water."

Surface (1913) and Mrs. Wilder (1913) give accounts of the food of *fusca*; Surface tabulating the contents of 235 stomachs, Mrs. Wilder of 18.

The food is composed of insects, arachnids, earthworms, snails, and isopods. Mrs. Wilder shows that cannibalism is occasionally indulged in, and that they eat their own moulted skin, as do toads and frogs. Surface found nematodes in two stomachs, but does not say whether they were parasites or not. I have found mites encysted under the epidermis in some specimens.

The life history has been thoroughly worked out by Mrs. Wilder (1913). The mating is on land, fertilization is internal and the eggs are laid on land. She gives the total number of eggs as 20, there

being usually 10 in each ovary. Her specimens were from near Northampton, Massachusetts. In a series from Haverford, Pennsylvania, females just matured at a length of 80 mm., had usually 28 eggs, while larger females up to 100 mm. had as many as 40 eggs. Cope states that 18 to 30 eggs may be found on one side.

The act of pairing has been observed in captivity on May 13. The eggs are laid from the first of June to the end of August, most being laid during July.

The eggs are guarded by the mother, who keeps herself in contact with them probably to keep them moist. They are joined together by the external membrane. The period from laying to hatching is about five weeks. When hatched the larvae measure 15 mm. There is a terrestrial larval stage of 15 to 16 days. At the expiration of this period the length is about 20 mm. and the larvae enter the water.

Mrs. Wilder gives the length of 15 aquatic larvae, collected in Massachusetts during November and December, as ranging between 17 and 25.5 mm. Seventeen larvae collected November 28, in Nelson County Virginia, ranged from 21 to 29 mm.

The aquatic larval period lasts about nine months. They transform during May and June. Thus during July and August, as a rule, no larval *fusca* will be found.

Mrs. Wilder gives the largest larva seen as 33 mm., and the smallest transformed specimen as 27.75 mm. This is at Northampton, Massachusetts. At Haverford, Pennsylvania, I have found larvae as large as 44 mm., and transformed specimens as small as 32 mm.

Mrs. Wilder says: "Specimens of 68 mm. and over of both sexes are sexually mature, apparently after three years of adult life. At Haverford they reach a larger size before maturity, although the age is probably the same. Females with developed eggs are not found smaller than 75 to 80 mm. The males lose the vomerine teeth at about 85 mm. This would be coincident with sexual maturity.

*Remarks.*—This is the most widespread form of the genus. With its subspecies *auriculata* it covers the whole East with the exception of the mountains of North Carolina.

Specimens intermediate between *fusca* and *auriculata* have been seen from Raleigh, Magnolia, and Kinston, North Carolina, Lake Drummond, Virginia, and Columbia, South Carolina. The Lake Drummond specimen is closer to *auriculata*, the others to *fusca*.

Specimens examined: 1,925, from localities as follows:

*New Brunswick.*—St. John's River, 1.

*Maine.*—Brooklin, 5; Westbrook, 1; Rangeley, 8.

*Vermont.*—St. Johnsbury, 2.

*Massachusetts.*—Berkshire Hills, 4; Springfield, 2; Northampton, 25.

*New Hampshire.*—Amherst, 3.

*Connecticut*.—Norfolk, 2; Redding, 1.

*Rhode Island*.—Providence, 1.

*New York*.—Adirondack, 1; Westport, 36; Ithaca, 21; Orange County, 1; Catskills, 15; Highland Falls, 16; Shokan, 8; Fort Lee, 16; Garrison, 12; Van Cortlandt Park, 1; Staten Island, 24; Long Island, 43; Tupper Lake, 1; Utica, 5; Hamburg, 6; Auburn, 3; Haines Falls, Catskills, 4.

*New Jersey*.—Orange, 11; Trenton, 1; Schwarzwood Lake, 2; Big Timber Creek, 1; Morristown, 15; Clement's Bridge, 10; Pennsville, Salem County, 111; Montclair, 4; Scotch Plains, 6; Maplewood, 2.

*Pennsylvania*.—39; Philadelphia County, 208; Delaware County, 6; Haverford, 74; Montgomery County, 55; Conshohocken, 10; Chester County, 14; Waynesburg, 3; Monocacy, 3; York County, 1; Lancaster County, 71; Altoona, 2; Indiana County, 17; Tuscarora, 1; Mifflin County, 8; Perry County, 3; Lehigh Gap, 8; Northampton County, 2; Warren County, 3; Port Allegheny, 3; Brooklyn, 1; Seven Bridges, 4; Pittsburgh, 13; Clinton County, 1; Broad Top Mountain, 14; Susquehanna County, 1; Carlisle, 473; Columbia County, 1; Meadville, 30; Centerville, 1.

*Delaware*.—Brandywine County, 2; Greenville, 4.

*Maryland*.—Gloucester, 2; Brookville, 1; Laurel, 1; Great Falls, 3; Cecil County, 3; Jennings, Garrett County, 1; Mount City Gap, 1.

*Virginia*.—Bailey's X-roads, 2; Fort Myer, 5; Munson's Hill, 1; Four-mile Run, 5; Fairfax County, 10; Stony Man Mountain, 21; Clarke County, 2; Berry's Ferry, Clarke County, 27; Giles County, 9; Somerset Beach, 1; Rockbridge County, 1; Bedford County, 3; Augusta County, 11; Newport News, 2; Nelson County, 33.

*Ohio*.—Cincinnati, 15; Columbus, 10; Highlands County, 4.

*Indiana*.—Richmond, 14; Brookville, 1; Jefferson County, 18.

*Illinois*.—Normal, 3.

*West Virginia*.—Kegley, 6; Big Spring Run, 1; Rich Mountain, near Beverly, 3.

*Kentucky*.—Morgan County, 3; Edmonson County, 1.

*North Carolina*.—Salem, 10; Kinston, 5; Magnolia, 2; Raleigh, 43; unknown locality, 1; French Broad River, 1; Ahseville, 9.

*Tennessee*.—1; Franklin County, 3; Knoxville, 3; Greenville, 1; Clearbon, 1; Athens, 1; Hamilton County, 6.

*South Carolina*.—Abbeville, 11; Columbia, 14.

*Georgia*.—Thompson's Mills, 1; unknown locality, 1.

*Alabama*.—Eutaw, 5; Dayton, 1; Auburn, 1.

*No locality*.—125.

DESMOGNATHUS FUSCA AURICULATA (Holbrook).

1838. *Salamandra auriculata* HOLBROOK, N. Amer. Herp., ed. 1, vol. 3, p. 115, pl. 28.

1849. *Desmognathus auriculatus* BAIRD, Journ. Acad. Nat. Sci., Philadelphia (n. s.), vol. 1, p. 286.



1854. *Cylindrosoma auriculatum* DUMÉRIl and BIBRON, *Erpétologie Générale*, vol. 9, p. 81.

1858. *Plethodon auriculatum* HALLOWELL, *Journ. Acad. Nat. Sci., Philadelphia*, (n. s.) vol. 3, p. 344.

1869. *Desmognathus fusca* var. *auriculata* COPE, *Proc. Acad. Nat. Sci., Philadelphia*, p. 116.

*Type*.—Not known to exist.

*Type-locality*.—Riceboro, Georgia.

*Distribution*.—From the Atlantic coast south of Dismal Swamp to Miami, Florida, and Washington, Mississippi. Zonal range: Lower Austral. Vertical range: Sea level to between 100 and 500 feet.

*Diagnosis*.—Similar to *fusca*, but a row of light spots on sides, slimmer, belly mottled, dark.

*Description*.—Vomerine teeth as in *fusca*. Parasphenoid patches shorter, separated from the vomerines by twice the length of one of the vomerine series. Tail similar to that of *fusca*, but slightly longer. The appressed toes fail to meet by four to four and a half intercostal spaces. The head length is from four to four and a half in the length of head and body. The head width is five and two-thirds to six in the length of head and body. The size is smaller than in *fusca*. The legs are weak and the tail is long. The head is narrower than in *fusca*.

The color is like that of *fusca*, but generally darker, especially ventrally. The belly, however, is always mottled. There is a line of light spots along the sides just above the insertion of the legs. This line is continued into the tail. The light spot between the eye and the angle of the jaw is especially noticeable in this form. It is said that these light spots are red in life. I have seen only alcoholics in which the color had faded.

*Habits*.—Nothing has been published on the habitat, food, or life history of this form save Lönnberg's (1894) statement that he found one in Florida "under a log in a wet hammock."

Its habits are probably similar to those of *fusca*. No larvae have been seen. The males lose the vomerine teeth at a length of about 90 mm., head and body 45 mm.

*Remarks*.—Intergrades with *fusca*. Its relationships with *fusca* have been discussed under that form.

Specimens examined: 74, from the following localities:

*Virginia*.—Lake Drummond, 1.

*North Carolina*.—Wilmington, 3; Lake Waccamaw, 5; Beaufort, 10.

*South Carolina*.—Unknown locality, 2; Manning, 1; Oakley, 9.

*Georgia*.—Unknown locality, 14; Savannah, 2; Nashville, 1; Riceboro (type-locality), 12.

*Florida*.—Jacksonville, 3; Green Cove Springs, 2; Miami, 1.

*Alabama*.—Codon 1; Mobile, 3.

*Mississippi*.—Unknown locality, 2; Washington, 1.

*Louisiana*.—Covington, 3; Clinton, 1; Mandeville, 1.

*No locality*.—Eight.

DESMOGNATHUS BRIMLEYORUM Stejneger.

1895. *Desmognathus brimleyorum* STEJNEGER, Proc. U. S. Nat. Mus., vol. 17, p. 598.

*Type*.—Cat. No. 22157, U.S.N.M. Collected by B. L. Combs, in 1894.

*Type-locality*.—Hot Springs, Arkansas.

*Distribution*.—Known only from the type-locality and Little Rock, Arkansas, Lower Austral Zone; altitude 500 to 1,000 feet.

*Diagnosis*.—Similar to *fusca*, but larger and much slimmer, with a row of light spots on sides as in *auriculata*, and belly mottled very pale. Tail keeled above. Vomerine teeth lacking in mature males. Transformed specimens: Total length 42–129 mm., females, 134 mm. males; head and body 27–71 mm., females, 82 mm., males.

*Description*.—Vomerine teeth lacking in mature males. When present they form two arched series, which contain 6 to 7 teeth each.

The parasphenoid series are quite variable. Long and narrow in small specimens; in adults they are usually short and thick and sometimes confluent anteriorly.

The tail is like that of *fusca*, but flatter and more finned above. The tail is always a good deal shorter than the head and body.

The head length is from 4 to  $4\frac{1}{2}$  in the length of head and body. The head width is from 5 to 6 in the length of head and body. The absence of the gular fold and the grooves of the face are noticeable only in the type series and are due to faulty preservation. More recent specimens show the gular fold and the facial grooves as well as any of the other species.

The mandibular dentition is as in *fusca*. The outline of the lower jaw is not so flexuous in the male and the glandular prolongation of the lower jaw is very weak. There is a noticeable difference in size between the males and females. There is always a tubercle canthus oculi. The costal grooves are 14 and rarely 15. There are 4 to  $4\frac{1}{2}$  intercostal spaces between the appressed toes.

This form has a narrow head, long slim body, short tail, and weak legs.

The color is much like that of *auriculata* on the dorsal surface. The lateral series of light spots are, however, heavily outlined with dark. The belly is mottled, but is paler than the belly of *fusca*.

*Habits*.—Strecker (1908) gives the following on *brimleyorum*, taken chiefly from the notes of B. L. Combs, who first collected them: "Combs's first specimens were found under the edges of flat rocks in the middle of a rather sluggish stream. Afterwards others were

found under planks, logs, and rocks, in damp woods in close proximity to water." They "would run at the slightest alarm."

Hurter and Strecker (1909) speak of *brimleyorum* eating specimens of *Spelerpes multiplicatus* with which they were confined.

No larvae have been seen. Strecker (1908) quotes from Combs's notes on the breeding habits: "In the latter part of August or early in September the female triton deposits her eggs, which are from 30 to 36 in number, and attached together in strings, in a crevice in the under side of a rotten log, or in a mass of decaying wood near some small stream. The eggs are about an eighth of an inch in diameter. The female is much attached to her eggs and seldom goes far away from them. During a dry spell she will carry them down into her hole with her, and if it rains again before they are hatched will bring them again to the surface." The life history is probably closely similar to that of *fusca*. The males lose the vomerine teeth at a length of about 95 mm.

*Remarks.*—This species and *auriculata* are the only forms of the genus that possess the lateral row of light spots. They are also the two slimmest forms with the weakest limbs. These facts and the geographical probabilities indicate that *brimleyorum* is a distinct, isolated, offshoot of *auriculata*.

*Specimens examined.*—37, from the following localities:

Arkansas.—Hot Springs (type-locality), 24; Little Rock, 12.

No locality.—1.

DESMOGNATHUS OCHROPHAEA OCHROPHAEA Cope.

1859 *Desmognathus ochrophaea* COPE, Proc. Acad. Nat. Sci., Philadelphia, p. 124.

1870 *Desmognathus haldemanni*<sup>1</sup> STRAUCH, Mém. Acad. Sci., St. Pétersbourg (7), vol. 14, p. 204.

1901 *Desmognathus fusca* ALLEN, Proc. Boston, Soc. Nat. Hist., vol. 29, pp. 73-74.

*Type.*—According to Stejneger, Cope's type of *ochrophaea* is catalogued in the United States National Museum as 4539. This entry bears in Baird's handwriting "type of supposed new species, *D. ochrophaea* Cope" and also in Cope's handwriting the one word "Destroyed."

*Type-locality.*—Susquehanna County, Pennsylvania.

*Distribution.*—From St. Johns River, New Brunswick and Adirondack Mountains, New York, south in the mountains to Garrett County, Maryland. Canadian zone.

*Diagnosis.*—Vomerine teeth lost in adult male. Parasphenoid patches separated. Tail cylindrical, without dorsal keel. A distinct color pattern. Belly, uniform, light. No tubercle canthus oculi. Transformed specimens: Total length, 22.5 to 94 mm. Head and body, 15 to 48 mm.

<sup>1</sup> *Salamandra haldemanni* Holbrook is judging from the plate a specimen of *Spelerpes bislineatus* in some stage of the metamorphosis. The gills are lacking, but in color and proportions it is an exact duplicate of certain metamorphosing larvae of *bislineatus* collected in August.

*Description.*—Vomerine teeth in a scarcely arched series, their base on a bony ridge. Parasphenoid series long, narrow, and entirely separate.

Mandibular dentition of adult male as follows: The teeth are large and confined to the part of the jaw anterior to the eye. The outline of the jaw is very strongly flexuous.

The tail usually shows no trace of a dorsal keel, but is cylindrical throughout and marked by strong segmental grooves as in the tail of *Plethodon erythronotus*. The tail is quite long proportionally, being frequently longer than the head and body. The tail of the female is longer than that of the male. Males reach a larger size than do females. The number of costal interspaces between the appressed toes is four.

The head length is from four to four and a half in the length of head and body. The head width is from five and a half to six in the length of head and body. The skin of the head is smooth. There is usually no tubercle in the anterior angle of the eye. By far the great majority of specimens seen lack it, but it is present in four specimens from Shokan, New York. The costal grooves are regularly fourteen. The color of this form is quite constant. The belly is always very light. The dorsal surface in old and large specimens is black. In all specimens in which the markings can be made out the dorsal surface is very light and there is a very dark, broad lateral band. The upper edge of this lateral band is straight and definite. The lower edge is indefinite, as the band gradually merges into the pale color of the ventral surface. Sometimes there are a few small spots along the median dorsal line. This occurs in medium and large specimens. Young specimens have the dorsal area immaculate and the color of it may be pink or yellow.

There is never any trace of the dorsal spots so conspicuous in the young of most other species of the genus. The black lateral band extends the length of the tail as does the light dorsal band, and the color of the tail is quite as characteristic of this species as is the shape of the tail.

*Habits.*—Cope (1889) claims that *ochrophaea* is strictly terrestrial, being found "under the bark of every fallen log of hemlock (*Abies canadensis*) and in the débris of the dark, damp forests of the North. I never saw one in the water of streams and river banks, the habitat of the other species of the genus."

Fowler (1906) gives an account of the habits of this species. Unfortunately he did not distinguish between this species and *fusca*, but of the 316 specimens in the Academy of Natural Sciences, collected by him in Potter and McKean Counties, Pennsylvania, 308 are *ochrophaea* and 8 are *fusca*. He says: "It was found everywhere in the valleys, about and in streams, and on the comparatively dry mountain tops,



though there less numerous and more solitary." Thus while *ochrophaea* can not be said to be strictly terrestrial, it seems more so than the other forms.

Cope says that the eggs are 6 to 10 in each oviduct. A large female from Potter County, Pennsylvania, had 10 on one side and 14 on the other. No larvae have been seen. Judging by the more terrestrial habitat, and the lack of the light dorsal spots, which are a larval character, the life history should differ from that of *fusca*. The males lose the vomerine teeth at a length of 65 to 75 mm. Females the same size have developed eggs.

*Remarks.*—This seems to be a northern offshoot of the next form. It is the only form in the genus which lacks the tubercle canthus oculi. Records and specimens from Ohio seem open to doubt. There are four very old specimens in the United States National Museum, numbered 3896, from Columbus, Ohio. Morse (1904) records it from Sugar Grove, Ohio. U. S. National Museum specimen 15634 from "S. Arizona and Texas," is even more open to doubt.

Specimens examined, 480, from localities as follows:

*New Brunswick.*—St. Johns River, 1.

*New York.*—Westport, 4; Catskills, 1; Allegheny County, 5; Shokan, 4; Hamburg, 8; Ithaca, 18; Haines Falls, Catskills, 12; Clinton County, 6.

*Pennsylvania.*—Meadville, 24; Indiana County, 12; Clinton County, 4; Broad Top Mountain, 3; Luzerne County, 17; Eaglesmere, 4; Susquehanna County (type-locality), 5; Potter County, 253; McKean County, 55; Warren County, 11; unknown locality, 24.

*New Jersey.*—Greenwood Lake, 1.

*Maryland.*—Garrett County, 11.

*Ohio.*—Columbus (?), 4.

"S. Arizona and Texas" (?), 1.

*No locality.*—3.

#### DESMOGNATHUS OCHROPHAEA CAROLINENSIS Dunn.

1916. *Desmognathus ochrophaea carolinensis* DUNN, Proc. Biol. Soc. Washington, vol. 29, p. 74.

*Type.*—Cat. No. 31135, U.S.N.M. Male adult. Collected by Brimley and Sherman, October 5, 1902.

*Type-locality.*—Mount Mitchell, North Carolina, spring near top, altitude "over 6,500 feet."

*Distribution.*—From Beverly, West Virginia, south in mountains to Gwinnett County, Georgia. Zonal range: Canadian zone. Vertical range: 2,200 to 6,500 feet.

*Diagnosis.*—Similar to *ochrophaea*, but with dark belly, and with a tubercle canthus oculi. Larger. Transformed specimens: Total length 25 to 113 mm; head and body, 54 mm.

*Description.*—The vomerines are always present in the female. They are lost by the male at maturity. Their shape and position as well as those of the parasphenoid series is as in *ochrophaea*.

The mandibular dentition is as in *ochrophaea*, save that the female has a more flexuous outline of the jaw than does the female in that



FIG. 15.—RANGES OF 1, *DESMOGNATHUS OCHROPHAEA OCHROPHAEA*; 2, *D. OCHROPHAEA CAROLINENSIS*. DOTTING SHOWS AREA OF INTERGRADATION.

species. The shape and proportions of the tail are just as in *ochrophaea*. There are 14 costal grooves. The proportions of the head are those of *ochrophaea*. There is always a tubercle canthus oculi. The skin of the head is usually finely rugose as in specimens of *quadrimaculata* and *monticola* from the North Carolina mountains.

The color is variable. Old specimens are uniformly black. As a rule the dorsal color is intermediate between that of *ochrophaea* and that of the *fusca* group. Thus there is a very dark lateral band

with sharply defined dorsal edges, but the back shows traces of an original series of light dorsal spots. The blackness of the sides of the tail is as characteristic of this form as of *ochrophaea*. Unlike *ochrophaea* the belly of *carolinensis* becomes black with age.

*Remarks.*—Although close to *ochrophaea* and undoubtedly intergrading with it in the mountains of northern West Virginia, this form tends toward the other species of the genus, with its dark belly and tubercle in the anterior angle of the eye.

This is a very variable and puzzling form. Some specimens are exactly like Northern *ochrophaea* in color; others are spotted. In these the dorsal coloration may be red or yellow. Most of the larger specimens are uniform purplish.

There is an unmistakable trend toward *fusca* in specimens from the French Broad Valley at Brevard. This is doubtless correlated with the difference in habitat from mountain specimens mentioned below. At Asheville in the French Broad Valley, *fusca* occurs.

It is quite possible that intergradation takes place, but until it is proved, I think it best to let *carolinensis* stand as a subspecies of *ochrophaea* because I believe *ochrophaea* to be derived from *carolinensis* rather than from *fusca*. At any rate the form *carolinensis* is between the form *fusca* and the form *ochrophaea* in characters.

Brevard *carolinensis* are much smaller than *fusca*; their coloration is like that of the mountain specimens in frequently having the immaculate dorsal stripe which *fusca* does not have; the tails of about half the specimens are cylindrical, half have the tail somewhat flattened, and a few of the smallest have a dorsal keel on the tail. Typical *fusca* has a decidedly flattened tail with an evident dorsal keel. Asheville specimens are like ordinary *fusca*, but seem slightly smaller.

Cope (1889) mentions this form as a variety of *ochrophaea*.

*Habits.*—In the low grounds of the French Broad River at Brevard, North Carolina, I found them in such places as *monticola* or *fusca* would frequent, but they rarely occurred with *monticola*, as the latter did not range into the low grounds. Higher up in the mountains, at Pink Beds and Linville *carolinensis* is almost wholly terrestrial. But occasional exceptions were found. Thus at Linville they were found everywhere from under a rock in water to under the bark of a tree five feet from the ground. By far the greater number, however, were under logs on the ground.

I found two females with eggs in July. They had 10 to 15 eggs apiece, a very small batch compared with the 30 eggs of average *fusca*.

No larvae have been seen and it is somewhat doubtful whether there is any definite aquatic larval stage.

The males lose the vomerine teeth at a length of 65 to 75 mm.

The largest specimen in the list of measurements must be a veritable giant, for out of a series of 213 which I got myself, the largest was 96 mm. in length.

Specimens examined: 296, from localities as follows:

*Georgia*.—Gwinnett County, 1; Tallulah Falls, 1.

*North Carolina*.—Mount Mitchell (type-locality), 19; Blantyre, 3; Highlands, 2; Brevard, 40; Pink Beds, 28; Tatula Mountain, 2; Andrews, 1; Wayah Bald, 2; Henderson County, 1; Haywood County, 11; Bald Mountain, Macon County, 1; Black Mountains, 8; Yancey County, 1; Cane River, 7; Pineola, 1; Linville, 135; Blowing Rock, 1; Roan Mountain, 8.

*Tennessee*.—Roan Mountain, 15.

*West Virginia*.—Star Creek, 1; Big Spring Run, 3; Rich Mountain, near Beverly, 1.

#### Genus *LEUROGNATHUS* Moore.

1899. *Leurognathus* MOORE, Proc. Acad. Nat. Sci. Philadelphia, 1899, p. 316.

*Type-species*.—*Leurognathus marmorata* Moore.

*Diagnosis*.—General characters of the Plethodontidae. Tongue attached, except by its lateral and posterior margins. Prefrontal bone wanting. Premaxillaries united, no fontanelle. Internal nares a foramen inclosed by the united vomers and maxillaries. Vertebrae opisthocoelous in the adult. Atlas without odontoid process and with a transverse dorsal ridge on which the temporal muscles originate. Occipital condyles on cylindric pedestals. Vomerine teeth not present. No light line from the eye to the angle of the jaw.

*Distribution*.—Same as that of the type-species.

#### *LEUROGNATHUS MARMORATA* Moore.

1899. *Leurognathus marmorata* MOORE, Proc. Acad. Nat. Sci. Philadelphia, 1899, p. 316.

*Type*.—Academy of Natural Sciences. Young male. Collected by Doctor Moore.

*Type-locality*.—Grandfather Mountain, North Carolina, stream between Linville and Blowing Rock, elevation about 3,500 feet.

*Distribution*.—Known only from the type-locality and from Roan Mountain, North Carolina.

*Diagnosis*.—No vomerine teeth. Legs stout. Two and a half to three intercostal spaces between appressed toes. Tail flattened, keeled and finned above. Head very large. Size large. No distinct color pattern. Belly black in old specimens. The total length of the five known specimens ranges from 98 to 128 mm. The length of head and body from 55 to 75 mm.



*Description.*—No vomerine teeth. The parasphenoid teeth form two leaf-shaped series which touch at the anterior end and are posteriorly distant.

The tail is shorter than the head and body, flattened and finned above and to a less extent below.

The head length is about four and a half in the length of head and body. The head width is about five and a half in the length of the head and body. In the Roan Mountain specimen the head is rugose like grain leather. In the type the head is quite smooth. The legs are stout. In the four from Grandfather Mountain there are two and a half intercostal spaces between the appressed toes. In the Roan Mountain specimen there are three. The costal grooves are 13, counting the axillary and inguinal. They are as in most *quadramaculata*. The color is much like that of *quadramaculata*, save that the dorsal coloration is lighter. The pattern is confused, but usually there is a double dorsal row of light spots without any definite borders. This coloration is intermediate between that of *D. quadramaculata* and that of *D. monticola*. The three smaller ones have the belly light while the two larger ones have it black. No sexual differences are evident.

I refer one larva caught in Grandmother Creek just below the lake to this species.

Moore's statement that *L. marmorata* is more aquatic than *Desmognathus quadramaculata*, the absence of adults or larvae in small streams near Linville which we searched thoroughly, and this larva from Grandmother Creek, all go to show that this species inhabits large streams. On several occasions we noticed salamanders in the Linville River. All those we could catch, however, turned out to be *Desmognathus quadramaculata*.

The larva shows *Desmognathine* affinities in its stout hind legs, glistening white gills, and dorsal fin only on the tail. No larvae known have all these characters save those of *Desmognathus*. It is much too large (63 mm.) for *monticola*, which transforms at 30 mm., or *carolinensis* which is even smaller.

In size and general appearance it agrees with larvae of *quadramaculata* collected at Brevard and Linville. It differs, however, in the much longer tail, the shorter and slimmer head, and the slimmer body.

Compare the proportions of several larvae:

	Length.	Head.	Body.	Tail.
	mm.	mm.	mm.	mm.
<i>Leurognathus marmorata</i> .....	63	8	21	31
<i>Desmognathus quadramaculata</i> .....	48	6	22	20
Do.....	52	8	23	21
Do.....	55	8	24	21
Do.....	59	9	25	25
Do.....	63	10	26	27
Do.....	63	10	34	22

The eyes are larger and farther apart. The head of a *quadramaculata* larva bears more resemblance to that of a pig, while this unique larva rather resembles a squid with its great staring eyes.

The color is much darker, although the pattern seems about the same. There is no light line from the eye to the angle of the jaw which line is quite evident in both larval and adult *quadramaculata*. Finally, the under side of the throat is pigmented, reminding one of the larva of *Gyrinophilus danielsi*. The throat of *quadramaculata* larvae is unpigmented.

While I think there can be no doubt that this larva is distinct from *D. quadramaculata*, I hesitated for some time before referring it to *Leurognathus marmorata*. *L. marmorata* differs very slightly in proportions from *D. quadramaculata*, and the color is usually lighter, especially in young specimens. Thus the larva would seem to differ from *marmorata* more than *quadramaculata* does. However there are only two possibilities; either this is the larva of *L. marmorata*, an animal known only from five specimens, four of which are from the Atlantic drainage on the slopes of Grandfather Mountain; or there exist in the Atlantic drainage on the slopes of Grandfather Mountain, two rather aquatic salamanders, much resembling *D. quadramaculata*, and known only from four adults and one larva, respectively.

*Habits*.—Nothing is known of their breeding habits. Doctor Moore says of them: "They seem to be essentially aquatic, remaining in the deeper parts of the pool and not burrowing beneath stones in places merely wet, as does the *D. nigra*, which occurs in great numbers in the same region. *L. marmorata* is much less active than the latter species and swims rather sluggishly, but with an easy gliding motion. The individuals seen seemed rather shy, and when alarmed quickly took refuge under the large rocks scattered through the pool, from beneath which, however, they were easily induced to emerge by the attraction of pieces of meat thrown into the water."

*Remarks*.—This species is externally very similar to *D. quadramaculata*, especially the two larger specimens, which are black. The flatness of the head is a very noticeable external character. I was looking over the specimens of *Desmognathus* in the collection of the academy, and one looked as if its head had been stepped on. It proved to be the Roan Mountain specimen of *Leurognathus*. This species is excessively rare and has had a rather curious history, as two out of the six known specimens have passed the time since the late nineties, when they were collected, under the name of *D. nigra*. Rhoads's specimen from Roan Mountain was collected in 1895, four years before the genus was described. Doctor Moore, who described the genus from three specimens, had four in his collection, but the resemblance of the adult to *D. quadramaculata* deceived him, as it had Rhoads.

Specimens examined from localities as follows:

*North Carolina*.—Stream between Linville and Blowing Rock, about 10 miles from the latter (type locality), 3; Blowing Rock, 1; Roan Mountain, 1; Pineola, 1.

#### DISCUSSION OF THE ORIGIN OF THE VARIOUS FORMS.

Adams (1902) gives 10 criteria for determining the center of dispersal of a related group of animals. These are:

1. Location of greatest differentiation of a type.
  2. Location of dominance or great abundance of individuals.
  3. Location of synthetic or closely related forms.
  4. Location of maximum size of individuals.
  5. Location of greatest productiveness and its relative stability.
  6. Continuity and convergence of lines of dispersal.
  7. Location of least dependence upon a restricted habitat.
  8. Continuity and directness of individual variations or modifications radiating from the center of origin along the highways of dispersal.
  9. Direction indicated by biogeographical affinities.
  10. Direction indicated by the annual migration routes in birds.
- The last is, of course, inapplicable in this instance.

In regard to the first criterion it has been shown that the three groups of *Desmognathus* occur together only in the southern Alleghenies.

In regard to abundance, Moore's already quoted remarks on *quadramaculata* apply, and Brimley (1912) says of *carolinensis*, "abundant throughout the regions collected in, particularly at the high altitudes" and of *quadramaculata* (with which he included *monticola*), "abundant, the most characteristic salamander of the rocky, mountain streams."

As to the third criterion, *monticola* and *carolinensis* are closer to *quadramaculata* than are any other members of their groups. *Quadramaculata* is the largest species in the genus, and *monticola* and *carolinensis* are the largest in their groups.

It has been shown that productiveness, judged by the number of eggs, is, in *fusca*, dependent on size. The largest *fusca* seen are from North Carolina, and in the mountains of that State occurs *monticola*, a close relative of *fusca*, and still larger.

The sixth and ninth criteria are closely similar and may be treated together. The dispersal of the *ochrophaea* group seems to have been northward along the mountains. The *fusca* group took the plains route radiating from the mountains as *fusca* and southward along the coast as *auriculata*. An isolated trans-Mississippi form of the latter has developed into *brimleyorum*. In Virginia and northward *fusca* has invaded the mountains into the range of *monticola*. It

seems to have originated eastward and gone around the mountains in Georgia and across them in northern Virginia and Pennsylvania. This convergence from two sides may account for the apparent absence of *fusca* in western Kentucky, western Tennessee, and northern Mississippi.

As to the seventh criterion, *Desmognathus* is found in the mountains of North Carolina in all situations; from far out in streams as large as the Linville River to under the bark of dead trees 5 feet from the ground.

The eighth criterion is satisfied by the southward increase in the size of *fusca* already referred to. If we arrange the species in the following order:

*quadramaculata*—*monticola*—*fusca* {*auriculata*—*brimleyorum*,  
*carolinensis*—*ochrophaea*,

we shall get by starting with *quadramaculata* definite and continuous variation in several characters; in size and importance of the dorsal larval areas, ending with the striped *ochrophaea*; in the size and importance of the lateral larval areas, ending with *brimleyorum*; in the hooking of the male mandible, ending with *ochrophaea*; in the shortening of the parasphenoid patches ending with *brimleyorum*; in the loss of the male vomerines and the shortening of the series in both sexes (not much change in this character or in that of discrepancy in size between the sexes takes place after *fusca* is reached); in the weakening of the limbs and the lengthening of the body, ending with *brimleyorum*; in terrestriality, ending with *ochrophaea*.

In the series ending with *brimleyorum* there is geographic continuity from the southern Alleghenies to Arkansas, but in the series ending with *ochrophaea* we apparently leave the mountains to develop *fusca* and enter them again to obtain *carolinensis*.

As an hypothesis to account for this peculiar distribution the following is put forward with considerable diffidence, as it rests on no fossil evidence:

C. C. Adams states that during the last glaciation there existed south of the ice first a tundra belt, then a coniferous forest, and lastly a deciduous forest. Now *monticola* and *fusca* are in general restricted to deciduous forests. We may place their glacial distribution as the glacial deciduous forest—*monticola* in the uplands and *fusca* in the lower land.

Possibly at this time *auriculata* and *brimleyorum* were developed in the extreme south, but more probably their differentiation is post-glacial.

During the last glaciation specimens of *fusca* invaded the glacial coniferous forest, acquiring less aquatic habits and an adaptation to a lower temperature, thereby or therewith being converted into *carolinensis*.



Morphologically, as I have shown, *carolinensis* is derived from *fusca*. Ecologically, while *fusca* and *monticola* have apparently similar habitats, actually the climate of the range of *monticola* is more humid than that of the range of *fusca*. Consequently, in degree of aquatic habitat, *fusca* is between *monticola* and *carolinensis*.

With the retreat of the ice *carolinensis* followed the coniferous forest to the southern mountains, where they both remain. Northern representatives of the form have developed into *ochrophaea*.

*Monticola* also retreated to the mountains because of the greater humidity. It now occupies the deciduous forest in the transition zone in the southern mountains.

Postglacially also occurred the overlapping of the ranges of *fusca* and *monticola*. It matters not whether we assign the differentiation of these two closely related, ecologically similar, forms to the period preceding the last glaciation or to that of the ice itself. At any rate, we are compelled to hypothesize for them ranges originally adjacent but distinct, differing in that the range of *monticola* was more humid. Perhaps it will best suit the facts of differentiation to suppose that prior to the last glaciation *monticola* occupied the mountains and *fusca* the piedmont and coastal plain.

It is highly probable that the entire extension of the genus west of the Appalachian Valley is postglacial, as neither *monticola* nor *quadramaculata* are known from the Cumberlands.

There are indications, such as the apparent isolation of *brimleyorum* in Arkansas and the rarity and disconnected range of *fusca* in Indiana and Illinois, that in early postglacial times forms of *Desmognathus* extended farther west than now. In this connection the remarks of Gaines (1895) on the recent extinction of *fusca* near Vincennes, Indiana; of McAtee (1907) on its former presence in Monroe County, Indiana; and Hahn's (1908) failure to find it in Lawrence County, Indiana, are of interest. It should be noted that failure to find *fusca* is of much greater significance than failure to find most other species of reptiles and amphibians, for where it is present it is much the commonest salamander.

For the differentiation of *monticola* from *quadramaculata* we do not need to assume a distinct geographic range, as they are ecologically different. But we are compelled to place the time of differentiation at a more remote period than that of any of the other forms, because *quadramaculata* is the most primitive as well as the most distinct form in the genus.

The above is only a hypothesis, and only in so far as it accounts for the known facts of distribution and relationship is it worthy of consideration. If it incites discussion and criticism the author will be well pleased.

Besides these arguments drawn from the species of *Desmognathus*, it is significant that in the southern Alleghenies occurs the only

species of the only closely allied genus, *Leurognathus marmorata*. I think I am justified by the above evidence in locating the center of dispersal of *Desmognathus* in the southern Alleghenies.

## MEASUREMENTS IN MILLIMETERS.

## DESMOGNATHUS QUADRAMACULATA (HOLBROOK).

Specimen.	Sex.	Length.	Head.	Body.	Tail.	Vomer- ine teeth.	Spaces be- tween toes. <sup>2</sup>	Locality.
U.S.N.M. 3923.....	Male....	151	.....	100	50	.....	.....	Abbeville, S. C.
U.S.N.M. 3923.....	Do.....	157	22	60	75	.....	.....	Do.
U.S.N.M. 14119.....	Do.....	112	17	61	44	6-6	2½	Wytheville, Va.
U. of Pa.....	Do.....	135	20	60	49	3-3	2½	Blowing Rock, N. C.
U.S.N.M. 30901.....	Female..	133	18.5	58.5	56	.....	.....	Linville, N. C.
U. of Pa.....	Do.....	129	17	57	55	.....	.....	Blowing Rock, N. C.
A.N.S. 915.....	.....	125	18	56	51	3-3	3	Henderson Co., N. C.
E.R.D.....	Male....	129	17	55	57	4-3	2	Haywood Co., N. C.
Do.....	Do.....	121	17	54	49	8-8	2	Do.
A.N.S. 923.....	Do.....	115	15	56	44	7-7	2½	Giles Co., Va.
A.N.S. 917.....	Do.....	129	18.5	54.5	56	3-3	2½	Do.
A.N.S. 918.....	Do.....	119	16	54	49	7-7	2½	Do.
E.R.D.....	Do.....	122	17	54	51	3-3	2	Grandfather Mt., N. C.
Do.....	Female..	104	16	53	35	6-8	2½	Haywood Co., N. C.
A.N.S. 916.....	Male....	119	16	50.5	49	7-7	2½	Giles Co., Va.
A.N.S. 920.....	Female..	115	15	49	51	6-6	3	Do.
E.R.D.....	Do.....	92	14.5	45.5	32	6-4	2	Haywood Co., N. C.
A.N.S. 919.....	Male....	105	16	44	45	5-4	.....	Giles Co., Va.
E.R.D.....	Do.....	94	11	38	45	5-5	2½	Haywood Co., N. C.
A.N.S. 913.....	Do.....	92	14	43	35	3-4	3	Henderson Co., N. C.
A.N.S. 921.....	Female..	73	13	37	23	5-5	3	Giles Co., Va.
A.N.S. 922.....	Do.....	81	11.5	34.5	35	.....	2½	Do.
U.S.N.M.....	Do.....	69	9	31	29	.....	3	Brevard, N. C.
A.N.S. 925.....	Do.....	78	11.5	29.5	37	4-4	3	Giles Co., Va.
U.S.N.M.....	Larva..	65	9	28	37	.....	3	Brevard, N. C.

U.S.N.M.: United States National Museum.

A.N.S.: Academy of Natural Sciences of Philadelphia.

M.C.Z.: Museum of Comparative Zoology at Cambridge.

E.R.D.: Collection of E. R. Dunn.

A.M.: American Museum of Natural History.

Cornell: Museum of Cornell University.

<sup>1</sup> Head and body.

<sup>2</sup> Of appressed limbs.

## DESMOGNATHUS MONTICOLA DUNN.

M.C.Z. 2546.....	Male....	112	16	52	64	0	3½	Blantyre, N. C.
Cornell.....	Do.....	106	14.5	51.5	40	0	.....	Clayton, Ga.
E.R.D.....	Do.....	112	15.5	48.5	48	2-4	3	Haywood Co., N. C.
Do.....	Do.....	120	15	48	57	3-4	3	Do.
Do.....	Female..	119	13.5	47.5	58	5-6	3	Blantyre, N. C.
U.S.N.M. 31116.....	Male....	101	14	47	40	3-3	2½	Yancey Co., N. C.
U.S.N.M. 38253.....	Do.....	135	14.5	46.5	74	3-2	3	Tatula Mt. near Highlands, N. C.
E.R.D.....	Female..	122	13	46	46	.....	3	Haywood Co., N. C.
U.S.N.M. 38251.....	Do.....	104	12.5	45.5	46	.....	3	Wayah Bald Mt., N. C.
U.S.N.M. 38314.....	Do.....	91	12	45	34	.....	3	Brevard, N. C.
U.S.N.M. 38313.....	Male....	116	12	45	58	3-3	3	Do.
U.S.N.M. 38316.....	Do.....	75	13	44	18	3-3	3	Do.
U.S.N.M. 31120.....	Do.....	107	11.5	41.5	54	4-5	2½	Yancey Co., N. C.
U.S.N.M. 38315.....	Female..	100	12	39	49	5-5	3	Brevard, N. C.
U.S.N.M. 31121.....	Do.....	93	11.5	34.5	47	.....	3	Yancey Co., N. C.
U.S.N.M. 48455.....	Do.....	79	9	28	42	.....	2	Brevard, N. C.
U.S.N.M. 38320.....	Do.....	58	7.5	27.5	23	.....	2	Do.
U.S.N.M. 38321.....	Larva..	63	7.5	25.5	30	.....	2	Do.
E.R.D.....	Do.....	55	7	20	28	4-5	2	Clarke Co., Va.
U.S.N.M. 38323.....	Do.....	46	7	19	20	.....	2	Brevard, N. C.
U.S.N.M. 38324.....	Do.....	36	5.5	14.5	16	.....	.....	Do.
U.S.N.M. 38325.....	Do.....	34	5	14	15	.....	.....	Do.
U.S.N.M. 38326.....	Do.....	31	5	12	14	.....	.....	Do.

<sup>1</sup> Type.

## DESMOGNATHUS FUSCA FUSCA (RAFINESQUE).

[All measurements taken from specimens in my own collection.]

Sex.	Length.	Head.	Body.	Tail.	Vomer- ino teeth.	Spaces between toes.	Locality.
Male.....	134	14	54	66	0	4½	Raleigh, N. C.
Do.....	128	14	53	61	0	.....	Conshohocken, Pa.
Do.....	116	13	52	51	0	4	Haverford, Pa.
Do.....	109	14	51	44	0	4	Midway, Va.
Do.....	119	12	50	57	0	4	Haverford, Pa.
Do.....	94	12	48	34	0	4½	Do.
Do.....	113	13	48	52	0	4	Midway, Va.
Do.....	100	12	46	42	0	4	Haverford, Pa.
Do.....	109	11	45	53	0	4	Do.
Female.....	100	10	42	48	3-3	4½	Do.
Do.....	102	9.5	41.5	51	6-3	4	Do.
Male.....	104	11	41	52	0	4	Clark Co., Va.
Female.....	107	11.5	40.5	55	3-4	4½	Midway, Va.
Do.....	93	9	40	44	3-4	5	Haverford, Pa.
Male.....	96	10	40	46	2-2	4	Do.
Do.....	99	10.5	38.5	50	1-	4	Clarke Co., Va.
Female.....	91	9.5	37.5	44	5-6	4	Haverford, Pa.
Male.....	81	11	36	33	0	4	Clarke Co., Va.
Female.....	81	8	35	38	3-3	5	Haverford, Pa.
Male.....	83	9	34	40	2-2	4	Do.
Do.....	73	9	33	31	2-2	4	Do.
Female.....	81	8	32	41	5-2	4	Do.
Do.....	75	8	31	36	3-3	4	Do.
Male.....	72	9	30	33	4-5	4	Midway, Va.
Do.....	71	9	30	32	4-4	4	Haverford, Pa.
Do.....	63	7.5	28.5	27	6-6	4	Do.
Do.....	67	8	28	31	4-4	4	Do.
Female.....	62	7	28	27	.....	4	Do.
Male.....	65	7	26.5	31.5	6-6	4	Do.
Female.....	64	7.5	25.5	31	.....	4	Clarke Co., Va.
Male.....	61	7	25	29	4-3	4	Haverford, Pa.
Female.....	60	7	25	28	3-3	4	Clarke Co., Va.
Do.....	58	7	23	28	3-3	4	Haverford, Pa.
Male.....	53	6.5	21.5	25	4-4	4	Do.
Female.....	52	6.5	20.5	25	.....	3	Clarke Co., Va.
Do.....	39	6	20	13	.....	4	Haverford, Pa.
Do.....	43	6	19	18	.....	.....	Do.
Do.....	39	5	17	17	.....	.....	Do.
Do.....	32	5	15	12	.....	.....	Do.
Do.....	27.5	4.5	14	9	.....	.....	Clarke Co., Va.
Larva.....	44	5	19	20	.....	.....	Haverford, Pa., May 28.
Do.....	33.5	4.5	15	14	.....	.....	Do.

## DESMOGNATHUS FUSCA AURICULATA (HOLBROOK).

Specimen.	Sex.	Length.	Head.	Body.	Tail.	Vomer- ine teeth.	Spaces be- tween toes.	Locality
M.C.Z. 2783.....	Male.....	107	13	49	45	0	4½	Mobile, Ala.
M.C.Z. 1070.....	do.....	103	14	48	41	0	4½	Jacksonville, Fla.
M.C.Z. 1070.....	Female.....	99	11	45	43	6-4	4	Do.
M.C.Z. 1070.....	do.....	106	10.5	43.5	52	.....	4½	Do.
U.S.N.M. 16675.....	Male.....	86	11.5	43.5	32	0	4½	Clinton, La.
M.C.Z. 2783.....	Female.....	89	11	42	36	3-5	4½	Mobile, Ala.
U.S.N.M. 21380.....	Male.....	101	11.5	40.5	49	0	4½	Savannah, Ga.
U.S.N.M. 21379.....	do.....	90	11.5	38.5	40	0	4½	Do.
U.S.N.M. 11899.....	do.....	85	11	38	36	0	.....	Mobile, Ala.
U.S.N.M. 45920.....	do.....	101	12.5	37.5	51	0	.....	Washington, Miss.
U.S.N.M. 37086.....	do.....	100	12.5	35.5	53	0	4½	Wilmington, N. C.
M.C.Z. 1168.....	do.....	75	9.5	31.5	31	5-5	4	Beaufort, N. C.
U.S.N.M. 37085.....	do.....	78	9.5	31.5	37	4-5	4	Wilmington, N. C.
M.C.Z. 2783.....	do.....	85	8.5	31.5	45	4-3	4	Mobile, Ala.
U.S.N.M. 37084.....	do.....	74	10	29	35	4-5	4	Wilmington, N. C.
M.C.Z. 1168.....	do.....	69	8.5	30.5	30	5-4	4½	Beaufort, N. C.
Do.....	do.....	60	8	27	25	3-4	4½	Do.

## DESMOGNATHUS BRIMLEYORUM STEJNEGER.

Specimen.	Sex.	Length.	Head.	Body.	Tail.	Vomer- ine teeth.	Spaces be- tween toes.	Locality.
M. C. Z. 2784.....	Male.....	134	17	65	52	0	5	Little Rock, Ark.
U.S.N.M. ....	do.....	128	16	58	54	0	4½	Do.
A. M. 506.....	Female ..	129	14.5	56.5	58	5-5	4½	Hot Springs, Ark.
A. N. S. 15785..	do.....	118	14	51	53	4-3	4	Little Rock, Ark.
M. C. Z. 2784..	Male.....	122	16	51	55	0	4½	Do.
U.S.N.M. 22165..	Female ..	105	13	50	41	.....	.....	Hot Springs, Ark.
M. C. Z. 2539..	Male.....	99	14	48	37	0	4½	Do.
U.S.N.M. ....	do.....	113	15	48	50	0	.....	Little Rock, Ark.
M. C. Z. 2784..	do.....	111	14	46	51	0	4½	Hot Springs, Ark.
U.S.N.M. 38797..	Female ..	105	12.5	44.5	48	5-7	4½	Do.
M. C. Z. 3142..	do.....	101	13	43	45	4-4	4½	Little Rock, Ark.
U.S.N.M. 22161..	do.....	93	12	43	38	.....	.....	Hot Springs, Ark.
U.S.N.M. 22163..	do.....	95	12	42	41	.....	4½	Do.
M. C. Z. 2784..	do.....	76	10	42	34	3-4	3	Little Rock, Ark.
U.S.N.M. 22169..	Male.....	93	.....	1 54	39	1	.....	Hot Springs, Ark.
U.S.N.M. ....	Female ..	93	11.5	41.5	40	7-7	.....	Little Rock, Ark.
U.S.N.M. 38796..	Male.....	93	11	40	42	4-4	3	Do.
U.S.N.M. 38798..	Female ..	80	10	34	36	6-6	4	Do.
U.S.N.M. 38799..	do.....	64	9.5	28.5	26	3-4	4	Do.
U.S.N.M. ....	.....	61	9.5	28.5	23	.....	.....	Do.
M. C. Z. 2784..	Female ..	60	8	28	24	5-5	3	Do.
U.S.N.M. 38800..	.....	59	8.5	27.5	23	7-6	3½	Do.
U.S.N.M. ....	.....	48	8.5	26.5	14	.....	.....	Do.
M. C. Z. 2784..	.....	57	8	25	25	.....	4	Hot Springs, Ark.
U.S.N.M. 38801..	.....	42	7	20	15	.....	3	Little Rock, Ark.

¹ Head and body.

## DESMOGNATHUS OCHROPHAEA OCHROPHAEA COPE.

[All specimens in list from Gold, Potter County, Pennsylvania. Duplicates in collection of Academy of Natural Sciences.]

Sex.	Length.	Head.	Body.	Tail.	Vomer- ine teeth.	Spaces between toes.
Male.....	90	10.5	37.5	43	0	4
Do.....	94	10.5	36.5	48	0	4
Do.....	87	10	35	42	0	3½
Do.....	65	10	34	21	0	4
Female.....	87	9.5	33.5	44	3-3	4
Male.....	85	10	33	42	0	4
Do.....	81	10	33	38	0	4
Female.....	83	9	32	42	3-4	3½
Do.....	84	9	32	43	3-3	4
Do.....	87	9.5	32	44	3-3	4
Male.....	92	10	31	51	0	4
Female.....	73	9	31	33	4-5	4
Male.....	69	7.5	30.5	31	4-4	4
Female.....	75	8	30	37	3-3	4
Do.....	79	9	30	40	5-5	3½
Do.....	72	9	29	34	6-4	3
Male.....	71	9	29	31	2-1	4
Do.....	65	8.5	28.5	28	0	4
Female.....	61	8.5	27.5	26	3-3	3
Male.....	45	9.5	27	8.5	3-2	4
Female.....	68	7.5	26.5	34	4-4	4
Do.....	67	8	26	33	4-4	4
Do.....	68	9	26	33	4-4	.....
Do.....	42	6	19	17	.....	4
Do.....	35	5	15	15	.....	.....
Do.....	31	5	15	11	.....	3



## DESMOGNATHUS OCHROPHAEA CAROLINENSIS DUNN.

Specimen.	Sex.	Length.	Head.	Body.	Tail.	Vomer- ine teeth.	Spaces be- tween toes.	Locality.
U.S.N.M. 31150.....	Male....	113	11	43	59	0	1	Mount Mitchell, N. C.
U.S.N.M. 31135 <sup>1</sup> .....	do.....	102	11.5	40.5	50	0	4	Do.
E. R. D. ....	do.....	80	9	34	.....	0	4	Haywood County, N. C.
Do.....	do.....	82	9.5	33.5	39	0	3	Do.
Do.....	do.....	78	9	33	36	0	4½	Do.
U.S.N.M. 31136.....	Female..	82	10	33	39	4-4	4	Mount Mitchell, N. C.
E. R. D. ....	Male....	77	9.5	31.5	35	0	4	Haywood County, N. C.
Do.....	Female..	60	8	31	21	6-6	4	Do.
Do.....	Male....	67	10	31	26	0	4	Do.
Do.....	do.....	76	11.5	29.5	35	0	4	Do.
Do.....	do.....	57	8	28	21	0	4	Do.
Do.....	Female..	71	8.5	27.5	35	6-6	4	Do.
Do.....	Male....	72	9	27	36	4-4	4	Do.
Do.....	do.....	58	7	26	25	4-2	4	Do.
Do.....	do.....	66	8.5	25.5	32	0	4	Cane River, N. C.
Do.....	do.....	64	8	24	32	4-4	4	Mount Mitchell, N. C.
U.S.N.M. 31137.....	do.....	65	8	24	32	4-4	3	Do.
E. R. D. ....	Female..	65	8	23	34	3-3	4	Cane River, N. C.
U.S.N.M. 31133.....	do.....	51	7	22	22	.....	.....	Mount Mitchell, N. C.
U.S.N.M. 31138.....	Female..	59	7.5	21.5	29	6-6	4	Do.
U.S.N.M. 31134.....	.....	44	6	18	20	.....	.....	Do.

## LEUROGNATHUS MARMORATA MOORE.

A. N. S. 4383.....	Male....	128	17	58	53	0	3	Roan Mountain, N. C.
U. of Pa. ....	Female..	120	15	54	51	0	2½	Blowing Rock, N. C.
Do.....	do.....	117	15	.....	.....	0	2½	Grandfather Mountain, N. C.
Do.....	do.....	108	14	41	31.5	0	2½	Do.
A. N. S. 4.....	Male....	98	13.5	46	41	0	2½	Do.
Am. Mus. 4519.....	Larva..	63	8	25	30	.....	.....	Pineola, N. C.

<sup>1</sup> Type.

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